Heuristic Scheduling: Running Away from the Bio-Inspired Tsunami

Rubén Ruiz*

Instituto Tecnológico de Informática. Grupo de Sistemas de Optimización Aplicada. Universitat Politècnica de València, Valencia, Spain

*Parts in collaboration with several co-authors

WORLO III

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1. The tsunami

- We all started with SA, TS, GAs…
- Then somewhere, somehow, things got out hand…

1. The tsunami

Claus Aranha @ Tsukuba University

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EC Bestiary

Updated May 3rd, 2017

> "Till now, madness has been thought a small island in an ocean of sanity. I am beginning to suspect that it is not an island at all but a continent." -- Machado de Assis, *The Psychiatrist*.

Introduction

The field of meta-heuristic search algorithms has a long history of finding inspiration in natural systems. Starting from classics such as Genetic Algorithms and Ant Colony Optimization, the last two decades have witnessed a fireworks-style explosion (pun intended) of natural (and sometimes supernatural) heuristics - from Birds and Bees to Zombies and Reincarnation.

The goal of the Evolutionary Computation Bestiary is to catalog the, ermm... exuberance of the meta-heuristic "eco-system". We try to keep a list of the many different animals, plants, microbes, natural phenomena and supernatural activities that can be spotted in the wild lands of the metaphor-based computation literature.

While we personally believe that the literature could do with more mathematics and less marsupials, and that we,

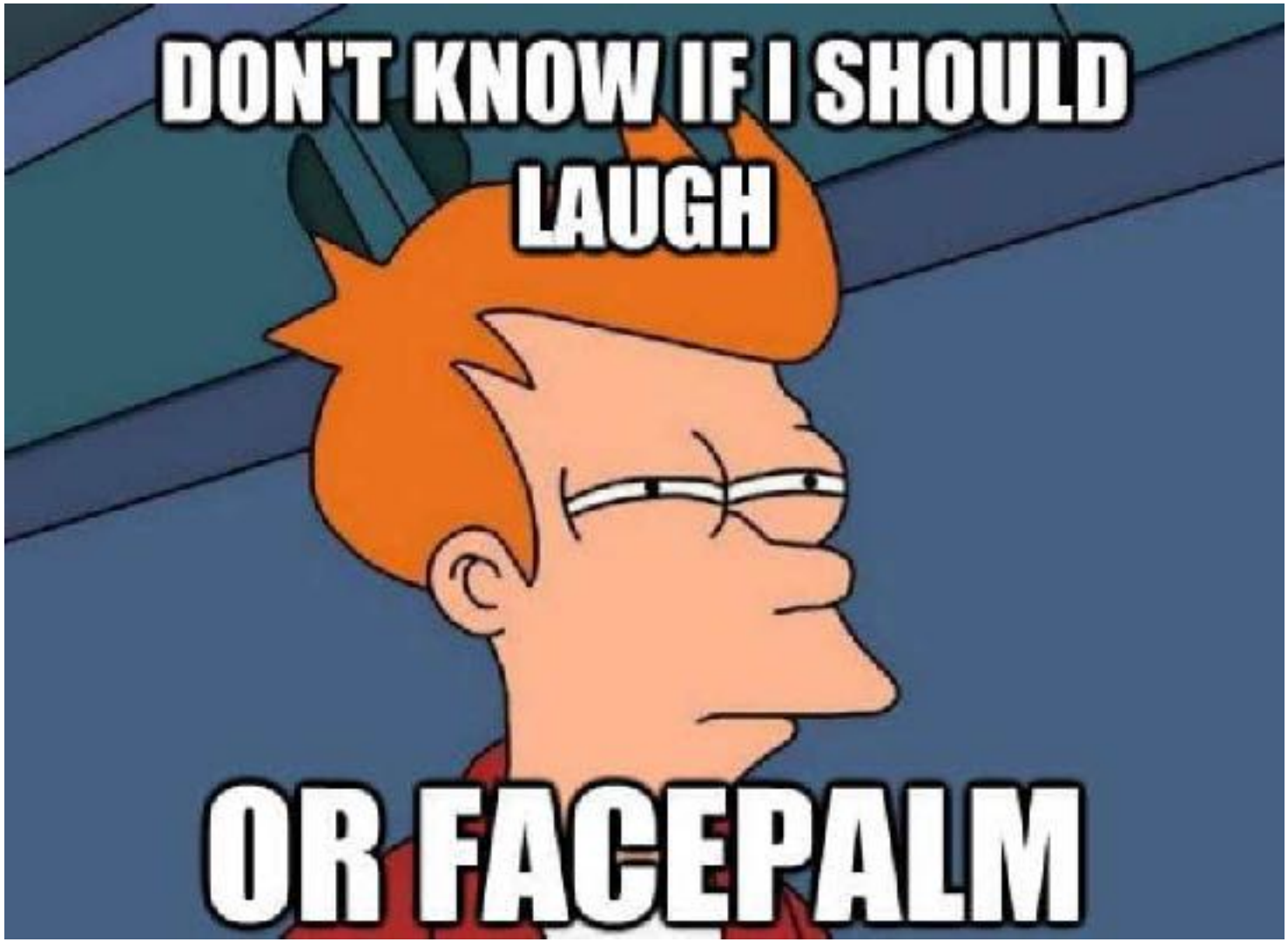
1. The tsunami

- http://conclave.cs.tsukuba.ac.jp/research/bestiary/

1. The tsunami

- >130 “unique” entries
- All kinds of animals, insects, plants, physical phenomena
- Interesting things like “Sperm motility algorithm”, “Intelligent Water Drops”, “Zombie Survival Optimization”, etc.
- Really bizarre things: “Small world”, “Reincarnation”, “Teachers”, “mine explosions”, “Consultants”

1. The tsunami



1. The tsunami

- Not all of this is published in bad journals. EJOR, IJPE, C&OR, JHeur, all big journals at some time involved
- Some papers have received thousands of citations
- Zong Woo Geem, Joong Hoon Kim, and G. V. Loganathan. "A new heuristic optimization algorithm: harmony search." Simulation 76(2): 60-68, 2001. 3656 citations in GScholar

2. The capital sins

- Many authors have been researching these and related issues

WILEY

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INTERNATIONAL TRANSACTIONS IN OPERATIONAL RESEARCH

Testing Heuristics: We Have It

J.N. HOOKER
Graduate School of Industrial Administration, Carnegie Mello

Abstract

The competitive nature of most algorithmic experimentation is
the research community. It is hard to make fair comparisons be
problems. Competitive testing tells us which algorithm is faster
it consumes time and energy that could be better spent doing mo
scientific approach of controlled experimentation, similar to that us
these problems. We have confused research and development;

Key Words: computational testing, benchmark problems

Metaheuristics—the metaphor exposed

Kenneth Sörensen

University of Antwerp, Operations Research Group ANT/OR, Prinsstraat 13 – B5xx, 2000 Antwerp, Belgium
E-mail: kenneth.sorensen@ua.ac.be (Sörensen)

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Abstract

In recent years, the field of combinatorial optimization has witnessed a true tsunami of "novel" metaheuristic methods, most of them based on a metaphor of some natural or man-made process. The behavior of virtually any species of insects, the flow of water, musicians playing together – it seems that no idea is too far-fetched to serve as inspiration to launch yet another metaheuristic. In this paper, we will argue that this line of research is threatening to lead the area of metaheuristics away from scientific rigor. We will examine the historical context that gave rise to the increasing use of metaphors as inspiration and justification for the development of new methods, discuss the reasons for the vulnerability of the metaheuristics field to this line of research, and point out its fallacies. At the same time, truly innovative research of high quality is being performed as well. We conclude the paper by discussing some of the properties of this research and by pointing out some of the most promising research avenues for the field of metaheuristics.

2. The capital sins

- My take on this issue. IMHO there are three main capital sins:
  1. Comparing only against cherry-picked methods or vanilla versions of the proposed bio-monster
  2. Peas-to-Melons comparisons
  3. Lack of sound statistical testing to check statistical significance of results
- 1 and 3 are well known and easy to spot. Let me focus on 2.

2. The capital sins

- Peas-to-Melons comparisons
  - Focusing only on solution quality, not considering (to some extent) CPU time
  - Metaheuristics use resources (CPU time, memory) to give a solution
- **Not carefully controlling CPU time in the comparisons leads to fallacies that are misleading (part) of the scientific community**

2. The capital sins

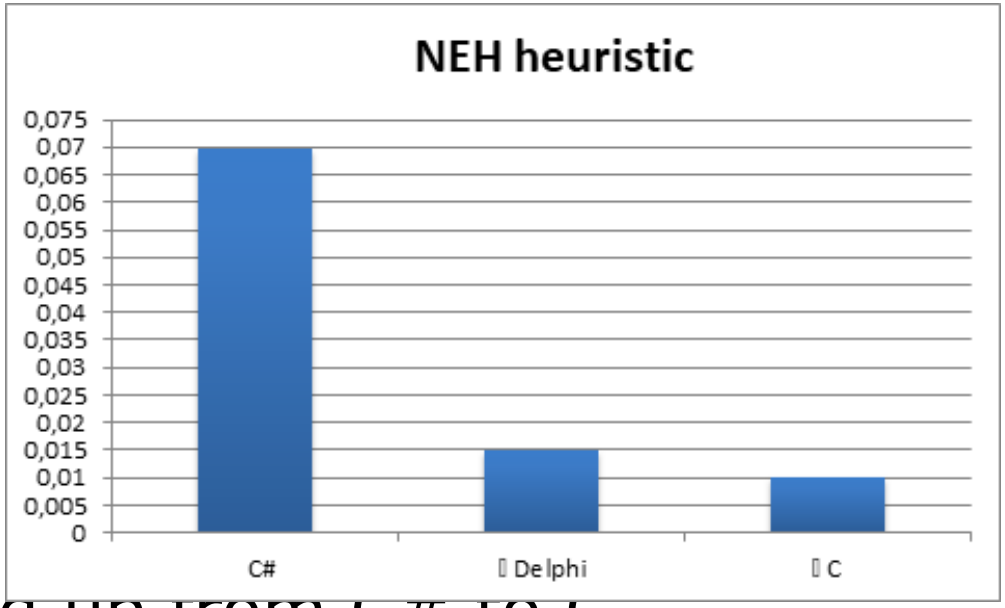
- Comparisons often against published tables with results obtained years ago:
  - Different processors (older)
  - Memory speed, bus speed (older)
  - Different compilers (older)
  - Different programming languages
  - Different operating systems
  - Different coding skills
  - Different stopping criteria
- These factors add-up!

2. The capital sins

- Corrections based on raw CPU frequency are utterly wrong
  - Intel Pentium 4 570 3.8 GHz (circa 2004)
  - Intel Core i7 4500U 1.8 GHz (circa 2013)
  - Older model more than twice the clock speed
- Some would think the older model is faster…
- … not true by a long shot. According to cpu.userbenchmark.com the new model is TWICE as fast with HALF the clock speed

2. The capital sins

- Is the compiler/language so important?



- 7x speed up from C# to C

2. The capital sins

- From Visual Studio 2013 to Visual Studio 2015 you get a 20% improvement in C# binary speed due to new compiler technology “Roslyn”
- Inlining/optimizing a frequently called function can improve code speed by two % digits
- How can we trust a 7% improvement in solution quality in a “new” method in a Peas-To-Melons comparison?

2. The capital sins

- Apples-to-apples comparisons:
  - REIMPLEMENT published algorithms
    - In the same language
    - Sharing most functions
    - Same coding skills
  - TEST in the same computer platform
    - Same processor, speed, architecture
    - Same compiler
    - Same OS
  - Run with used thread CPU-time as stopping criterion
  - Carry out statistical testing for significance

2. The capital sins

- What authors are doing as a result of the Peas-to-Melons comparisons:
  - "New" ideas easily best published methods in "comparable" running times
  - The better results of the "new" ideas are basically the compounded effect of a faster CPU, newer compilers, etc.
  - "Hybridized" versions of existing methods are seen as "better" just because they run on **newer hardware** not because they are actually better

3. Keep it simple, stupid

- Very simple template. Iterated Greedy:

procedure Iterated_Greedy
  $\pi_0 :=$ GenerateInitialSolution
  $\pi :=$ LocalSearch(π_0)
  while (termination criterion not satisfied) **do**
    $\pi_D :=$ Destruction(π)
    $\pi' :=$ Reconstruction(π_D)
    $\pi'' :=$ LocalSearch(π')
    $\pi :=$ AcceptanceCriterion(π'', π)
  endwhile
end

3. Keep it simple, stupid

- Average RPD Results for a regular flowshops:
- Simpler methods work better

Method	NEHT	GA_RMA	HGA_RMA	SA_OP	SPIRIT	GA_CHEN	GA_REEV
AVRPD	3.35	1.13	0.57	2.37	5.09	4.83	1.61

Method	GA_MIT	ILS	GA_AA	M_MMAS	PACO	IG_RS	IG_RS_{LS}
AVRPD	2.42	1.06	2.28	0.88	0.75	0.78	**0.44**

3. Keep it simple, stupid

ρ =30

	IG_{RLS}	DDE_{RLS}	EDA_J	VNS_J	ILS_D	HGA_{T1}	HGA_Z	HGA_{T2}
AVRPD	0.39	0.39	*7.72*	4.88	0.49	2.23	0.74	5.29

	AGA	hDDE	DABC	SLS	IGA	pIGA	ILS	pILS
AVRPD	0.87	0.64	0.83	0.41	**0.24**	0.28	0.25	0.31

ρ =60

	IG_{RLS}	DDE_{RLS}	EDA_J	VNS_J	ILS_D	HGA_{T1}	HGA_Z	HGA_{T2}
AVRPD	0.36	0.36	*7.02*	4.39	0.49	2.13	0.63	4.50

	AGA	hDDE	DABC	SLS	IGA	pIGA	ILS	pILS
AVRPD	0.78	0.60	0.76	0.41	**0.24**	0.27	0.25	0.30

ρ =90

	IG_{RLS}	DDE_{RLS}	EDA_J	VNS_J	ILS_D	HGA_{T1}	HGA_Z	HGA_{T2}
AVRPD	0.35	0.4	*6.64*	4.17	0.50	2.09	0.59	4.09

	AGA	hDDE	DABC	SLS	IGA	pIGA	ILS	pILS
AVRPD	0.72	0.58	0.74	0.40	**0.24**	0.27	0.25	0.29

3. Keep it simple, stupid

- RPD Results for a distributed flowshop. Simpler methods work better:

ρ	HIA	SS	BSIG	IG
20	10.54	1.80	0.97	0.60
40	10.06	1.64	0.83	0.45
60	9.78	1.55	0.77	0.37
80	9.58	1.49	0.72	0.32
100	9.37	1.45	0.69	0.28
Average	9.87	1.59	0.80	**0.40**

3. Keep it simple, stupid

- The pattern is similar for many different scheduling problems:
  - The simpler, the better
  - When complex bio-monsters are stripped from the eye-opening "operators" results improve…
  - …if tested in an apples-to-apples setting
- The old-known diversification-intensification combo is enough for most scheduling problems

4. The fix

- We have a big problem in the community
- We are not going to be taken seriously if we do not put a remedy to this problem
- In apples-to-apples comparison scenarios all the wild ideas expectedly fail
- Time has come to stop being permissive with this research as it is hurting us all

4. The fix

- RTHOTP
  - Reject
  - The
  - Hell
  - Out of
  - These
  - Papers
- Rinse and repeat *ad-nauseam*

4. The fix

Filthy SPAM!

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